EX VIVO MICROLEAKAGE COMPARISON BETWEEN GLASS IONOMERS USED AS PIT AND FISSURE SEALANTS

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ABSTRACT

The aim of this study was to evaluate in vitro the marginal microleakage of two glass ionomer materials used as pit and fissure sealants. Thirty healthy premolars extracted for orthodontic treatment were randomly assigned to two groups (n=15) and respectively sealed with two glass ionomers (Group I, Fuji VII and Group II, Fuji IX). All teeth were preserved in artificial saliva (NAF) for 10 days, thermocycled (250 cycles; 5ºC, 37ºC and 60ºC), isolated, and immersed in 2% alcohol gentian violet blue solution for 24 h. After washing, teeth were included in acrylic resin and sectioned longitudinally in a bucco-lingual direction with a Struers-Minitom cutting device. Samples were analyzed for leakage using an optical microscope (Olympus BX-60M). TheWilliams and Winter semi-quantitative ranked scale was used to score dye penetration. In Group I the grades were distributed as follows: Grade 1, 1 sample and Grade 3, 14 samples (Mean 2.87 Median 3, SD 0.52). In Group II: Grade 0: 4 samples, Grade 1, 3 samples, Grade 2, 2 samples and Grade 3, 6 samples (Mean 1.67, Median 2, SD 1.29). Fisher's exact test showed statistically significant differences between materials (p=0.006). From these results, we conclude that Fuji IX had better marginal sealing than Fuji VII when used as a pit and fissure sealant.

Key words: *leakage, pit and fissure sealants, glass ionomer.*

COMPARACIÓN *IN VITRO* DE FILTRACIÓN MARGINAL ENTRE IONÓMEROS VÍTREOS SELLADORES

RESUMEN

El objetivo del trabajo fue comparar la eficacia como sellador de dos ionómeros vítreos. Se emplearon 30 premolares sanos extraídos por razones ortodóncicas. Se dividieron en dos grupos iguales (n=15) .Grupo I: Fuji VII y Grupo II: Fuji IX. Los dientes, fueron conservados en saliva artificial (NAF) durante 10 días. Luego, fueron termociclados (250 ciclos) a 5ºC, 37ºC y 60ºC. Posteriormente se sumergieron en violeta de genciana durante 24 hs. Una vez lavadas las muestras se seccionaron y evaluaron con el criterio de Williams y Winter, utilizando un microscopio óptico (Olympus BX-60M) para valorar la penetración del colorante. Los grados obtenidos para cada grupo fueron: en Grupo I (Fuji VII), Grado 1, 1 muestra y Grado 3, 14 muestras (Media 2,87, Mediana 3 y SD 0.52). En el Grupo II (Fuji IX) los grados se distribuyeron así: Grado 0, 4 muestras, Grado 1, 3 muestras, Grado 2, 2 muestras y Grado 3, 6 muestras. (Media 1.67, Mediana 2 y SD 1.29). La Prueba exacta de Fisher (p=0,006) demostró diferencias estadísticamente significativa entre materiales. Se concluyó que el mejor sellado marginal fue obtenido utilizando el material Fuji IX comparado con Fuji VII cuando es utilizado como sellador.

Palabras Clave: *Filtración, Sellador de fisuras, Ionómero vítreo.*

INTRODUCTION

During the last three decades the prevalence of caries has declined worldwide[1]. However, this decline has not been uniform on different tooth surfaces. Pits and fissures in human molars have been recognized as sites that are susceptible to dental caries[2]. Lack of post-eruptive maturation and contact with the antagonist favor the development of carious lesions[3]. We also know that pit and fissure caries account for the majority of carious lesions, 93.4% and 79.8%, respectively, in 12-year old children[4,5]. This high percentage can be attributed to the complex morphology of pits and fissures, which are ideal for retaining bacteria and food debris, making removal extremely difficult [6]. Their extreme vulnerability has prompted researchers to look for methods to prevent these situations [7]. Fig. 1 shows the typical appearance of a tooth surface.

Methods for preventing dental caries should pay particular attention to surfaces with pits and fissures, which have always been the first to be affected. Occlusal caries are more prevalent in children as a result of the morphology of surfaces with pits and fissures, which are vulnerable areas where plaque that is formed is anatomically protected from toothbrush filaments due to the size of the cracks. It seems likely that the period most susceptible to caries of a first permanent molar is the long eruptive phase. The immature enamel and the ignorance on the part of the child and the parents of the presence of tooth eruption further hinder good dental hygiene in this area [8].

Two materials which have different properties are currently used to seal pits and fissures: resins and glass ionomer cements. While resin sealants can prevent seepage of nutrients from the oral cavity into the cracks, glass ionomer cements inhibit caries by releasing fluoride ions [9,10]. During the eruptive period of the first permanent molar, absolute isolation of the operative field is impossible, preventing the sealing of pits and fissures with resin sealants.

Fissure sealing with glass ionomer cements was introduced by McLean and Wilson in 1974 [11]. Glass ionomer cements can adhere chemically to the tooth structure, are less hydrophobic than resinous sealants, and release fluoride ions, providing a valid alternative in situations where there is high probability of contamination during application of the sealant [12]. Despite the high loss of ionomeric macroscopic sealants, they have a caries preventive effect because the material remaining at the bottom of the pits and fissures can act as a slow release depot of rechargeable fluoride ions [13-17]. Conventional glass ionomers are difficult to handle and have low resistance to wear and fracture. The high density glass ionomer developed for the atraumatic restorative technique (Fuji IX, GC and Ketac Molar, 3M ESPE) has greatly improved physical properties [18].

The recently introduced Fuji VII glass ionomer (GC, Tokyo, Japan) offers the ideal properties for a pit and fissure sealant [7]. This pink glass ionomer allows quick identification by dentist and patient, and the presence of this pigment absorbs light energy. Setting time can be accelerated and mixing time is reduced by using light bulb radiation of appropriate wavelength and intensity. Moreover, its rate of fluoride release is more than 6 times higher than in Fuji IX [19].

The aim of this study was to evaluate microleakage by the degree of penetration of dye into the pits and fissures of premolars extracted for orthodontic reasons and sealed with Fuji VII and Fuji IX.

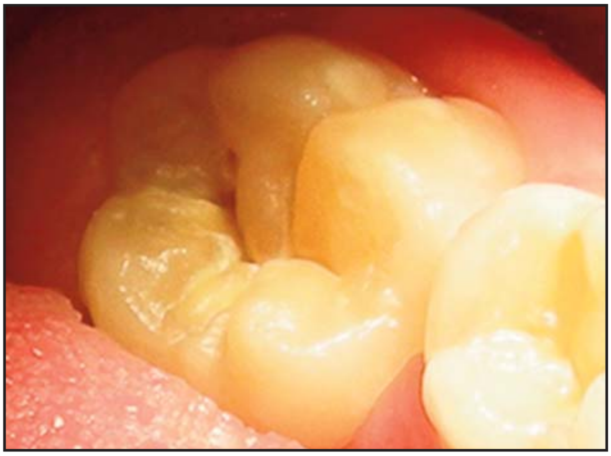

Fig. 1: Clinical Occlusal view of mandibular first permanent molar.

MATERIALS AND METHODS

Thirty first and second, upper and lower healthy premolars extracted for orthodontic reasons were selected to be used as samples.They were divided into two equal groups (n =15) as follows:

Group 1: sealed using the ionomer Fuji VII (GC, Tokyo, Japan).

Group 2: sealed using the ionomer Fuji IX (GC, Tokyo, Japan).

Sample Preparation

The thirty premolars were cleaned with a prophylaxis brush to remove any remaining plaque biofilm or residual stains. Then they were washed with water with a triple air/water syringe from the dental kit and kept in artificial saliva at room temperature for 15 days (Naf Oral Solution, NAF Laboratories, Buenos Aires, Argentina).

Sealing of samples

The material was applied following the manufacturer's instructions. The steps were:

1. Remnants of the occlusal surfaces were removed with water and a prophylaxis brush attached to a low-speed handpiece.
2. Occlusal surfaces were washed with water and dried gently.
3. The occlusal surfaces of the premolars of both groups were treated with 10% polyacrylic acid for 30 seconds and then washed with water and dried with cotton rolls to prevent desiccation of the surfaces.

4. Materials were prepared according to manufacturer's instructions.
5. The capsule material was placed in a syringe provided with the sealant kit.
6. The teeth were sealed with Fuji VII or Fuji IX by keeping the syringe tip at the end of the fissure until the completion of the sealant application to prevent air bubble formation.
7. Fuji VII was polymerized with a light lamp (Coltolux® 75, Coltene, USA) for 20 seconds. For teeth sealed with Fuji IX, the initial setting was indicated by loss of gloss of the material.
8. Sealing surfaces were then protected with petroleum jelly to prevent drying of the material in its initial curing periods.

Thermocycling

Thermocycling was performed to simulate the oral cavity environment at 5 °C, 37 °C and 60 °C for 250 cycles with a period of 30 seconds in between. The low temperature cycle was obtained with ice and water in a glass beaker. Higher temperatures were obtained with water in a container at controlled temperatures. Then teeth were stored in artificial saliva for 15 days, ensuring that they were completely immersed.

Dye penetration and acrylic inclusion of teeth

Samples were removed from the artificial saliva and immersed in a 2% alcohol gentian violet solution for 24 hours [7]. Teeth were then washed in running water to remove excess dye.

Then the root portion of the teeth was removed. The crown portion of each premolar was included in self-curing acrylic to create a contact surface between the tooth and the cutting machine. Premolars were sectioned with a Struers- Minitom electric cutting machine with diamond-coated disks. The cut was performed in a bucco-lingual direction.

Polishing of samples

Surfaces of interest were prepared for viewing under a microscope using a grinding and polishing protocol. Grinding was performed with a sequence of grain size 500, 1000 and 2000 sandpaper using a metallographic polishing machine Prazis PUL-01 model with running water cooling. Polishing was performed using the same polishing machine with polishing cloths and a series of 3 and 0.25 micrometer diamond pastes (Prazis), respectively.

Microscope observation

Once polished, samples were cleaned with running water and dried with air (dryer at room temperature). The samples were then placed under an optical reflection microscope (Olympus BX- 60M, USA) to evaluate the extent of penetration of the dye in the material-tooth interface.

For evaluation, the Williams and Winter criterion [20] of Grades was applied:

Grade 0: no dye penetration.

Grade 1: penetration extending 1/3 of the total length of the interface between the sealant and the dental structure (depth of groove).

Grade 2: penetration extending between 1/3 and 2/3 of the total length of the interface.

Grade 3: penetration extending beyond 2/3 of the total length of the interface.

RESULTS

Evaluation of Marginal Sealing

Table 1 shows the results obtained. The number of samples with each grade is shown for each group. Two different degrees of dye penetration are shown as examples in Fig. 2, sealed with Fuji VII and Fuji IX respectively. Fig. 3 show details of Fuji IX adhesion to enamel surface.

The complete results were analyzed with Fisher's exact test (p=0.006) and showed statistically significant differences between the two materials, indicating that Group 2 (Fuji IX) provided better marginal sealing that Group 1 (Fuji VII).

Table 1: Dye Penetration in premolars sealed with Fuji VII and IX. *Significant difference between two groups (p=0.006)*

	Fuji VII	Fuji IX
Grade 0 (without penetration)	0	4
Grade 1 (1/3 penetration)	1	3
Grade 2 (2/3 penetration)	0	2
Grade 3 (more than 2/3 penetration)	14	6
Total	15	15

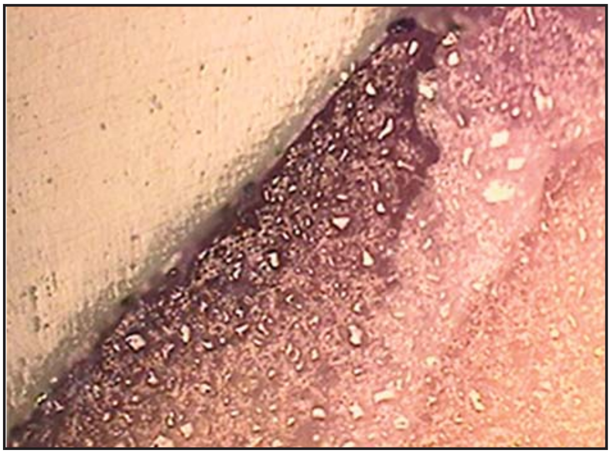

Fig. 2: Microphotography dye penetration: a: Fuji VII: Grade 3. b: Fuji IX: Grade 0. Light microscopy, Magnification 12.5x.

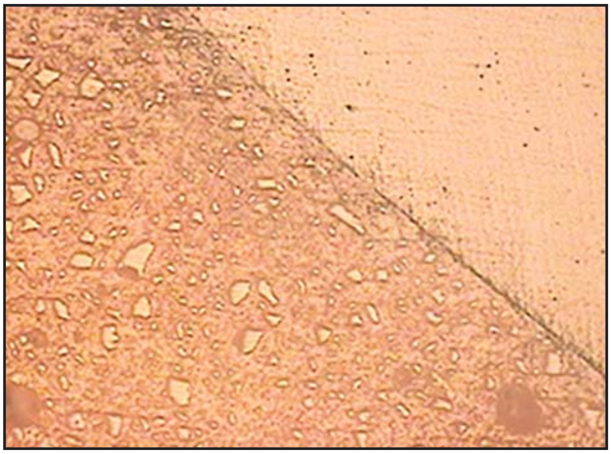

Fig. 3: Microphotography showing good adhesion with Fuji IX to adamantine wall (right side). Arrows shows interface. Light microscopy, Magnification 125x.

DISCUSSION

The prevalence of caries in pits and fissures emphasizes the importance of sealants in preventing caries [21].

The effectiveness of sealants lies in their ability to isolate pits and fissures from bacteria, nutrients and metabolic product acids[22]. Sealants are the best preventive measure against caries, pits and fissures, especially in those patients at high cariogenic risk such as children with incisive molar hypomineralization[23-25].

The clinical effectiveness of pit and fissure sealants is directly related to their retention, which depends on pit and fissure morphology, proper insulation, characteristics of the sealant material and application techniques. Furthermore, sealant retention can be improved by cleaning the occlusal surface before insertion, using prophylaxis pastes, air abrasion and mechanical preparation of fissures, known as invasive techniques. Another factor in the success of the sealer is marginal integrity, which can be evaluated by measuring microleakage. This can be defined by the entry of bacteria and oral fluids into the space between the tooth and the restorative material [26].

The ability of a sealant to prevent microleakage is an important parameter, since a carious process can be initiated and sustained under the sealant [27].

The advent of new directions for the use of glass ionomers such as pit and fissure sealants has made it necessary to re-examine their physical characteristics and application techniques. *In vitro* studies have allowed us to determine marginal leakage and predict the marginal sealing ability of different materials used as pit and fissure sealants [26].

In this study, *in vitro* microleakage was assessed by measuring dye penetration between the sealant and the tooth structure following the criteria of Williams and Winter. The results, analyzed with Fisher's exact test (p=0.006), showed statistically significant differences between the two materials, indicating that Fuji IX I provided better marginal sealing than Fuji VII.

With respect to marginal sealing ability, there are numerous works in the literature studied that analyze the clinical and *in vitro*behavior of Fuji VII compared to different resinous sealants (i.e. Concise) [7], with the conclusion that the latter has more satisfactory behavior. The authors based their findings on the pattern of tooth-sealant bond and on the poor resistance to marginal leakage of ionomers. However, other authors report different results, concluding that there is no difference in microleakage (p> 0.05) when comparing Fuji VII and Concise resin sealant (3M) [27]. Traditionally, glass ionomer cements are not used as pit and fissure sealants because of the risk of microleakage. However, the increased resistance to microleakage of glass ionomer cement Fuji VII can be explained on the basis of enamel conditioning prior to chemical adhesion to enamel structure and absence of polymerization shrinkage [27]. The results of our study agree with those reported by these authors in relation to marginal sealing ability, although they indicate that Fuji IX was better than Fuji VII.

In 2011, Singla[26] conducted an *in vitro* comparison of microleakage between Fuji II LC and Dyract Flow with fluoride release using non-invasive and invasive application techniques. Fuji II LC is a resin-modified glass ionomer and Dyract Flow is a fluid compomer. More microleakage was found in the glass ionomer. This can be attributed to different reasons but the most acceptable one is the solubility of the glass ionomer in the oral environment. It should be noted that the glass ionomer is hydrophilic and tends to absorb dye, thus giving false positive results. The use of the dye in *in vitro* studies simulates bacteria and their products. The leakage of the dye into the ionomer structure would not be important since, when simulating bacterial biofilm, it would be neutralized by the effect of the fluorine contained in the material [26] and in this study we did not consider dye penetration into the structure of the materials employed. However, in this study, potential false positives would cancel each other out since we compare the same materials with similar hydrophilicity values that neutralize this limitation.

CONCLUSIONS

Under the experimental conditions studied Fuji IX showed better marginal sealing than Fuji VII.

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